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Analysis and control of some nonlocal 1D first-order hyperbolic systems

(Abstract for the general public)

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Many different physical phenomena can be described by *local* one-dimensional (1D) first-order hyperbolic systems. These well-established mathematical models are used for instance to describe road traffic, shallow water flows, heat exchangers, chemical reactors, gas pipes and many other phenomena. The local nature of these models stems from the importance of nearby environmental effects.

Nowadays, *nonlocal* versions have also emerged to successfully model various phenomena that naturally arise in many area of science. This includes include again road traffic, but also epidemic phenomena, chemotaxis, Ohmic heating production, insect swarm dynamics and many more. As opposed to local models, the usage of nonlocal models to describe phenomena is required when distant individuals or nonlocal environmental effects have a prevailing role. Therefore, these models make use of all the information and, in a sense, makes them more accurate and realistic than local ones.

The objective of this research project is to study an important class of such nonlocal systems and to tackle one fundamental property called *controllability.* Roughly speaking, a system is controllable if, given an initial configuration and a final configuration, it is somehow possible to act on the system such that it reaches this final configuration after some time. For instance for road traffic, this may come down to answering the following question: is it possible to regulate the traffic flow on a highway by means of a device in order to achieve a specific traffic flow fixed beforehand ? Such a device is called "control", thus the name controllability. In the previous example, this role can be played for instance by a traffic light at the entrance of the highway.

The current mathematical literature for the proposed class of systems is very limited. Besides, many techniques previously used with success to investigate the controllability of *local* systems or nonlocal *uncoupled* equations run into serious problems. In this research project, we will try to develop new tools that can be implemented to deal with the current issues. Answers are essential in view of the aforementioned potential applications. The project will open up new horizons.